CLAIMS

1. A magnetic sensor comprising:

a plurality of sense layers, including a ferromagnetic pinned layer that has a magnetization that is stable in response to an applied magnetic field, a soft magnetic free layer that has a magnetization that rotates in response to the applied magnetic field, and a nonferromagnetic spacer layer that separates the pinned layer from the free layer, the free layer extending between two ends in a track-width direction; and

a ferromagnetic bias layer structure that is separated from the free layer by an electrically conductive spacer layer, the bias layer structure having a first section extending between two edges in the track-width direction such that the ends of the free layer are magnetically coupled to the edges of the first section, the bias layer structure having a second section that is separated from the electrically conductive spacer layer by the first section, the second section extending at least twice as far as the first section in the track-width direction.

2. The sensor of claim 1, further comprising a soft magnetic shield that is disposed adjacent to a first of the ends, such that a line that intersects the ends and is parallel to the track-width direction intersects the shield.

3. The sensor of claim 2, wherein the shield is separated from the first end by a nonferromagnetic insulating layer.

4. The sensor of claim 1, further comprising a soft magnetic shield that is disposed adjacent to both of the ends, such that a line that intersects the ends and is parallel to the track-width direction intersects the shield adjacent to each of the ends.

5. The sensor of claim 1, wherein the first section is a first magnetic layer and the second section is a second magnetic layer.

6. The sensor of claim 1, further comprising a soft magnetic shield that is separated from the bias layer structure by a nonferromagnetic layer.

7. The sensor of claim 1, wherein the nonferromagnetic spacer layer is electrically conductive.

8. The sensor of claim 1, wherein the nonferromagnetic spacer layer includes a plurality of heterogeneous materials.

9. The sensor of claim 1, wherein the nonferromagnetic spacer layer is made of dielectric material.

10. The sensor of claim 1, further comprising an antiferromagnetic structure that is magnetically coupled to the pinned layer.

11. The sensor of claim 1, wherein the pinned layer is a first part of a pinning structure, the pinning structure including a second part that is made of hard magnetic material that extends at least twice as far as the pinned layer extends in a stripe-height direction that is perpendicular to the track-width direction.

12. A magnetic sensor comprising:

a plurality of sense layers, including a ferromagnetic pinned layer that has a magnetization that is stable in response to an applied magnetic field, a soft magnetic free layer that has a magnetization that rotates in response to the applied magnetic field, and a nonferromagnetic spacer layer that separates the pinned layer from the free layer, the free layer extending between two ends in a track-width direction; and

a ferromagnetic pinning structure that has a first section extending a first distance in a stripe-height direction that is perpendicular to the track-width direction such that the first section is antiferromagnetically coupled to the pinned layer by a nonmagnetic metal layer, the pinning structure having a second section that is separated from the metal layer by the first section, the second section extending a second distance in the stripe-height direction, wherein the second distance is at least twice the first distance.

13. The sensor of claim 12, further comprising a soft magnetic shield that is separated from the second section by a nonferromagnetic layer.

14. The sensor of claim 12, further comprising a soft magnetic shield that is disposed adjacent to the free layer, such that a line that intersects the free layer and is parallel to the track-width direction intersects the shield.

15. The sensor of claim 14, wherein the shield is separated from the first end by a nonferromagnetic insulating layer.

16. The sensor of claim 14, wherein the shield surrounds the free layer in the track-width direction.

17. The sensor of claim 12, wherein the first section includes a first magnetic layer and the second section includes a second magnetic layer.

18. The sensor of claim 12, wherein the metal layer contains ruthenium, chromium, rhodium, iridium or copper, and has a thickness that is less than two nanometers.

19. The sensor of claim 12, further comprising a soft magnetic shield that is separated from the free layer by a nonferromagnetic layer.

20. The sensor of claim 12, wherein the spacer layer is electrically conductive.

21. The sensor of claim 12, wherein the spacer layer includes a plurality of heterogeneous materials.

22. The sensor of claim 12, wherein the spacer layer is made of dielectric material.

23. The sensor of claim 12, further comprising a ferromagnetic bias layer structure that is separated from the free layer by an electrically conductive, nonmagnetic layer, the bias layer structure having a first part extending between two edges in the track-width direction such that the ends of the free layer are magnetically coupled to the edges of the first part, the bias layer structure having a second part that is separated from the electrically conductive, nonmagnetic layer by the first part, the second part extending at least twice as far as the first part in the track-width direction.

24. A magnetic structure comprising:

a ferromagnetic layer that extends in a first direction a first distance;

a nonferromagnetic spacer layer that adjoins the ferromagnetic layer and extends in the first direction a second distance that is substantially equal to the first distance; and

a ferromagnetic structure that is separated from the ferromagnetic layer by the spacer layer, the ferromagnetic structure having a first section that extends in the first direction a third distance that is substantially equal to the second distance, the ferromagnetic structure having a second section that is disposed further than the first section from the spacer layer, the second section extending at least twice as far as the first section in the first direction.

25. The structure of claim 24, wherein the spacer layer is made of electrically conductive material.

26. The structure of claim 24, wherein the spacer layer includes a plurality of heterogeneous materials.

27. The structure of claim 24, wherein the spacer layer is made of dielectric material.

28. The structure of claim 24, wherein the first and second sections are made of substantially the same material.

29. The structure of claim 24, wherein the ferromagnetic structure is a layer that is notched at opposite ends of the first section.

30. The structure of claim 24, wherein the first section is made of a first layer and the second section is made of a second layer.

31. The structure of claim 24, wherein the spacer layer contains ruthenium, chromium, rhodium, iridium or copper, and has a thickness that is less than two nanometers.

32. The structure of claim 24, wherein the ferromagnetic layer has a magnetic moment that rotates in the presence of an applied magnetic field, and the ferromagnetic structure has a magnetic moment that does not rotate in the presence of the applied magnetic field.

33. The structure of claim 24, further comprising a soft magnetic layer that is separated from the ferromagnetic layer by a second nonferromagnetic spacer layer, wherein the soft magnetic layer has a magnetic moment that rotates in the presence of an applied magnetic field, and the ferromagnetic layer has a magnetic moment that does not rotate in the presence of the applied magnetic field.

34. A magnetic structure comprising:

a ferromagnetic layer that extends in a first direction between two ends;

an electrically conductive, nonmagnetic spacer layer that adjoins the ferromagnetic layer; and

a ferromagnetic structure that is separated from the ferromagnetic layer by the spacer layer, the ferromagnetic structure having a first section extending between two edges in the first direction such that the ends of the ferromagnetic layer are magnetically coupled to the edges of the first section, the ferromagnetic structure having a second section that is separated from the spacer layer by the first section, the second section extending at least twice as far as the first section in the first direction.

35. The structure of claim 34, wherein the ferromagnetic layer has a magnetic moment that rotates in the presence of an applied magnetic field, and the ferromagnetic structure has a magnetic moment that does not rotate in the presence of the applied magnetic field.

36. The structure of claim 34, further comprising a soft magnetic layer that is separated from the ferromagnetic layer by a nonferromagnetic layer, wherein the soft magnetic layer has a magnetic moment that rotates in the presence of an applied magnetic field, and the ferromagnetic layer has a magnetic moment that does not rotate in the presence of the applied magnetic field.

37. The structure of claim 34, wherein the spacer layer contains ruthenium, chromium, rhodium, iridium or copper, and has a thickness that is less than two nanometers.